

October 19, 2016

Arthur Burbank
USDA Forest Service
4350 South Cliffs Dr.
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**Subject: Biological Selenium Removal Treatment Technology
 Fluidized Bed Bioreactor Pilot Study
 September 2016 Progress Report**

Dear Art,

This progress report summarizes key activities in September 2016 associated with the fluidized bed bioreactor (FBR) pilot study located near Hoopes Spring. This pilot study is being conducted as part of the Smoky Canyon Mine Remedial Investigation/Feasibility Study (RI/FS) to provide information on the effectiveness of the active biological treatment system in removing selenium and other COPCs from South Fork Sage Creek Springs and Hoopes Spring. Operation and monitoring of the pilot study follows the *Pilot Study Work Plan and Sampling and Analysis Plan (Work Plan/SAP), Biological Selenium Removal Treatment Technology Fluidized Bed Bioreactor* (prepared by Formation Environmental, dated September 2014, with revised text and tables dated March 5, 2015), along with Work Plan/SAP Addenda 01 through 04.

Weekly sample collection during the 12-week performance testing period was completed on June 28, after which sampling has been conducted every other week. The system is currently operational, and samples collected during the month of September were analyzed for both the full and focused analyte list, as specified in the Work Plan/SAP.

The following sampling events were conducted in September 2016:

- Week 21 sampling on September 2 (third quarter sample, full analyte list)
- Week 23 sampling on September 15 (focused analyte list)
- Week 25 sampling on September 28 (focused analyte list)

Identification of Deliverables and Data Transmittals

At the time of this report, the 12-week performance testing has been completed, and laboratory data for Weeks 21, 23, and 25 of the every other week testing period have been received. The Week 21 sample was the third quarter sample, and was analyzed for the full analyte list. Preliminary laboratory data are presented in Table 1.1 (full analyte list) and Table 1.2 (focused analyte list). Field data for Weeks 21, 23, and 25 of the every other week monitoring period are presented in Table 2.

There were no outstanding deliverables or transmittals for the month of September.

Upcoming Activities

The following activities associated with the FBR pilot study are planned through October 2016:

- As per the Work Plan/SAP, sample collection will continue every other week (focused analyte list only).
- Preparation of the Work Plan/SAP for Phase 2 of the FBR treatability study, which includes addition of ultra-filtration and reverse osmosis and an increase in treatment system flow capacity.

Please contact me if there are questions regarding this monthly progress report.

Sincerely,

Monty Johnson
Environmental Engineering Manager
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Table 1.1
Laboratory Results Full Analyte List

		Week 21	
		Influent	Effluent
	Station >>	SC0916-LSSHS-IN001	SC0916-LSSHS-EF001
	Sample ID >>	9/2/2016	9/2/2016
Analyte	Units		
General Chemistry			
Ammonia as N	mg/L	0.026 U	1.09
Bicarbonate	mg/L	180	180
Biochemical Oxygen Demand	mg/L	2 U	2 U
Carbonate	mg/L	1 U	1 U
Chemical Oxygen Demand	mg/L	5 U	5 U
Calcium, Dissolved	mg/L	57.4	55.2
Magnesium, Dissolved	mg/L	22.8	22.8
Potassium, Dissolved	mg/L	0.684	0.649
Sodium, Dissolved	mg/L	5.37	5.34
Chloride	mg/L	7.39	14.2
Fluoride	mg/L	0.25	0.238
Hardness	mg/L	237	232
Nitrate as N	mg/L	0.45	0.18
Nitrate/Nitrite as N	mg/L	0.446	0.267
Sulfate as SO4	mg/L	36.3	36.3
Total Alkalinity	mg/L	180	180
Total Dissolved Solids	mg/L	360	300
Total Organic Carbon	mg/L	0.5 U	0.667 J
Total Phosphorus as P	mg/L	0.0398	0.166
Total Sulfide	mg/L	1 U	1 U
Total Suspended Solids	mg/L	2 U	2 U
Metals and Metalloids			
Aluminum, Dissolved	mg/L	0.0076 U	0.0076 U
Aluminum, Total	mg/L	0.0076 U	0.0076 U
Antimony, Dissolved	mg/L	0.00012 J	0.0000732 U
Antimony, Total	mg/L	0.00012 J	0.0000732 U
Arsenic, Dissolved	mg/L	0.000398 U	0.000398 U
Arsenic, Total	mg/L	0.00043 J	0.000398 U
Barium, Dissolved	mg/L	0.0468	0.0316
Barium, Total	mg/L	0.0473	0.0317
Beryllium, Dissolved	mg/L	0.000047 U	0.000047 U
Beryllium, Total	mg/L	0.000047 U	0.000047 U
Boron, Dissolved	mg/L	0.00723 J	0.00721 J
Boron, Total	mg/L	0.00746 J	0.00624 J
Cadmium, Dissolved	mg/L	0.0000362 U	0.0000362 U
Cadmium, Total	mg/L	0.0000362 U	0.0000362 U
Chromium, Dissolved	mg/L	0.00061 J	0.00007 J
Chromium, Total	mg/L	0.00061 J	0.00007 J
Cobalt, Dissolved	mg/L	0.0001 J	0.00356
Cobalt, Total	mg/L	0.00009 J	0.00345
Copper, Dissolved	mg/L	0.0000418 U	0.0000418 U
Copper, Total	mg/L	0.0000418 U	0.0000418 U
Iron, Dissolved	mg/L	0.01 U	0.0316 J
Iron, Total	mg/L	0.15	0.833
Lead, Dissolved	mg/L	0.0000554 U	0.0000554 U
Lead, Total	mg/L	0.0000554 U	0.0000554 U
Manganese, Dissolved	mg/L	0.00048 J	0.0171
Manganese, Total	mg/L	0.00049 J	0.0169
Mercury, Dissolved	mg/L	0.000017 J	0.000017 J
Mercury, Total	mg/L	0.000113 J	0.000109 J

Table 1.1
Laboratory Results Full Analyte List

		Week 21	
		Influent	Effluent
	Station >>	SC0916-LSSHS-IN001	SC0916-LSSHS-EF001
	Sample ID >>	SC0916-LSSHS-IN001	SC0916-LSSHS-EF001
Analyte	Date >>	9/2/2016	9/2/2016
	Units		
Molybdenum, Dissolved	mg/L	0.00247	0.00665
Molybdenum, Total	mg/L	0.0016	0.00624
Nickel, Dissolved	mg/L	0.00062 J	0.00779
Nickel, Total	mg/L	0.00031 J	0.00789
Selenate	mg/L	0.102	0.00005 U
Selenite	mg/L	0.000193	0.00338
Selenium, Dissolved	mg/L	0.139	0.00613
Selenium, Total	mg/L	0.127	0.00559
Silver, Dissolved	mg/L	0.0000172 U	0.0000172 U
Silver, Total	mg/L	0.0000172 U	0.0000172 U
Thallium, Dissolved	mg/L	0.00009 J	0.0000657 U
Thallium, Total	mg/L	0.0000657 U	0.0000657 U
Uranium, Dissolved	mg/L	0.00155	0.00122
Uranium, Total	mg/L	0.00158	0.00124
Vanadium, Dissolved	mg/L	0.00148 J	0.00041 J
Vanadium, Total	mg/L	0.00146 J	0.00041 J
Zinc, Dissolved	mg/L	0.000102 U	0.00474 J
Zinc, Total	mg/L	0.000102 U	0.00439 J

Notes:

Results presented are preliminary, and have not been validated at the time of this report.

U - Analyte not detected above the method detection limit (MDL).

J - Result is estimated.

Table 1.2
Laboratory Results Focused Analyte List

Biological Selenium Removal Treatment Technology
 Fluidized Bed Bioreactor

		Week 23		Week 25	
		Influent	Effluent	Influent	Effluent
		SC0916-LSSHS-IN002	SC0916-LSSHS-EF002	SC0916-LSSHS-IN003	SC0916-LSSHS-EF003
		9/15/2016	9/15/2016	9/28/2016	9/28/2016
Analyte	Units				
General Chemistry					
Nitrate as N	mg/L	0.45	0.16	0.44	0.2
Total Phosphorus as P	mg/L	0.0141	0.574	0.005 U	0.214
Total Sulfide	mg/L	1 U	1 U	1 U	1 U
Metals and Metalloids					
Selenium, Dissolved	mg/L	0.127	0.00534	0.126	0.00841
Selenium, Total	mg/L	0.125	0.00534	0.124	0.00853

Notes:

Results presented are preliminary, and have not been validated at the time of this report.

U - Analyte not detected above the method detection limit (MDL).

J - Result is estimated.

Table 2
Field Water Quality Data

Week 21	Station >>	Influent	Effluent
	Sample ID >>	SC0916-LSSHS-IN001	SC0916-LSSHS-EF001
	Date >>	9/2/2016	9/2/2016
Analyte	Units		
Dissolved Oxygen	mg/L	8.26	7.4
ORP	mV	237	171
pH	SU	7.01	6.61
SC	umhos/cm	471	481
Temperature	C	13.06	12.83
Turbidity	NTU	2.2	9.3

Week 23	Station >>	Influent	Effluent
	Sample ID >>	SC0916-LSSHS-IN002	SC0916-LSSHS-EF002
	Date >>	9/15/2016	9/15/2016
Analyte	Units		
Dissolved Oxygen	mg/L	8.51	7.61
ORP	mV	219	180
pH	SU	7.42	6.82
SC	umhos/cm	480	472
Temperature	C	13.13	12.79
Turbidity	NTU	2.6	11.1

Week 25	Station >>	Influent	Effluent
	Sample ID >>	SC0916-LSSHS-IN003	SC0916-LSSHS-EF003
	Date >>	9/28/2016	9/28/2016
Analyte	Units		
Dissolved Oxygen	mg/L	8.23	7.97
ORP	mV	203	177
pH	SU	7.15	6.99
SC	umhos/cm	464	481
Temperature	C	12.88	13.68
Turbidity	NTU	0.9	9.5